Fermion Wave Function in the VEQF Framework

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Abstract

The Vacuum Energy Quanta Field (VEQF) framework redefines mass and gravity as emergent properties of a quantized lattice of Vacuum Energy Quanta (VEQ), synonymous with space and Dark Energy. This paper derives a deterministic, timeless wave function for Standard Model fermions, modeled as stable standing wave vortices sustained by transactional interactions with the lattice. The wave function includes ripple modulation representing trickle re-charge from the VEQ field, with collapse occurring when transactional velocity reaches the speed of light c. The derivation uses a refined lattice node spacing $l_q \approx 7.894781519 \times 10^{-21}$ m, consistent with prior VEQF models, and is validated numerically for fermions like the electron, up quark, strange quark, and top quark. The speculative nature of the lattice model is acknowledged, positioning VEQF as a hypothesis open to validation.

1. Introduction

In the Vacuum Energy Quanta Field (VEQF) framework, space is a timeless thermodynamic lattice of energy quanta, and mass and gravity emerge from entropy-driven interactions. The Mass Emergence Model (MEM) describes mass as vortex structures, while the Gravity Emergence Model (GEM) interprets gravity as mass drift toward low-entropy destinations. This paper derives a fermion wave function consistent with these principles, modeling particles as stable standing wave vortices with ripple modulation from the VEQ field. Wave function collapse is defined as physical disintegration when transactional velocity reaches c. The derivation leverages the lattice node spacing $l_q \approx 7.894781519 \times 10^{-21}$ m, aligning with prior VEQF work, pending further validation.

2. Derivations

The fermion wave function is derived within VEQF, interpreting particles as lattice vortices with deterministic, non-probabilistic dynamics.

2.1 Key Parameters

- **Planck Constant**: $h = 6.62607015 \times 10^{-34} \, \mathrm{J \cdot s} = \mathrm{kg \cdot m^2 \cdot s^{-1}}$.
- **Reduced Planck Constant**: $\hbar = \frac{h}{2\pi} \approx 1.054571817 \times 10^{-34} \, \mathrm{J \cdot s}$.
- **Speed of Light**: $c = 299792458 \, \mathrm{m \cdot s^{-1}}$.
- **Lattice Node Spacing**:

$$l_q \approx 7.894781519 \times 10^{-21} \text{ m}$$

$$l_q^3 \approx 4.920626 \times 10^{-61} \text{ m}^3$$

- **Lattice Energy Density**:

$$\rho = \frac{h}{l_q^3} \approx \frac{6.62607015 \times 10^{-34}}{4.920626 \times 10^{-61}} \approx 1.346591 \times 10^{27} \text{ kg} \cdot \text{m}^{-1} \cdot \text{s}^{-2}$$

- **Coupling Constant**: $k \approx 1.00297175 \times 10^{-26}$, recalibrated for MEM.
- **Electron Rest Mass**: $M_0 = 9.1093837 \times 10^{-31}$ kg.
- **Vortex Parameters**: $\Delta x = 2.4 \times 10^{-12}$ m, interaction radius; $\beta = 1.0$, scaling factor; $\epsilon = 10^{-4}$, ripple support coefficient; $N = 5$, number of ripple modes.

ρ represents the lattice's quantum energy density, and l_q defines the VEQ lattice scale.

2.2 Fermion Wave Function Derivation

The fermion wave function is defined as:

$$\psi(\vec{r}, \text{TCI}) = A \cdot e^{i \cdot \vec{k}(\text{TCI}, \Delta f) \cdot \vec{r}} \cdot \left[1 + \epsilon \cdot \sum_{j=1}^{N} \sin\left(\frac{j \cdot \vec{r}}{l_q} \right) \right]$$

Where:

- $\vec{r}$: Position vector across vortex core.
- A: Normalization factor derived from rest energy.
- $\epsilon \approx 10^{-4}$: Ripple support coefficient.
- $N = 5$: Number of active ripple modes.
- $l_q \approx 7.894781519 \times 10^{-21}$ m: Lattice spacing.
- $\vec{k}$: Wavevector dependent on Transactional Coherence Index (TCI) and frequency mismatch Δf.

Mass from MEM:

$$m(n) = \text{TCI}^2 \cdot \left(M_0 + \beta \cdot \frac{h \cdot \Delta f}{c^2} \right)$$

Momentum:

$$p = m \cdot v = m \cdot c$$

Wavevector:

$$\vec{k} = \frac{p}{\hbar} = \frac{2\pi}{h} \cdot \text{TCI}^2 \cdot \left(M_0 c + \frac{h \cdot \Delta f}{c} \right)$$

Normalization factor:

$$A = \frac{1}{\sqrt{m \cdot c^2}}$$

Saturation threshold:

$$\vec{k}_{\text{sat}} = \frac{2\pi k}{l_q^3} \cdot (\Delta x)^2$$

Units for $\vec{k}$:

$$\frac{\text{kg} \cdot \text{m} \cdot \text{s}^{-1}}{\text{kg} \cdot \text{m}^2 \cdot \text{s}^{-1}} = \text{m}^{-1}$$

Units for $\vec{k}_{\text{sat}}$:

$$\frac{(\text{dimensionless}) \cdot \text{m}^2}{\text{m}^3} = \text{m}^{-1}$$

The wave function reflects vortex stability, with collapse at $\vec{k} \geq \vec{k}_{\text{sat}}$, indicating disintegration into lattice ripples.

2.3 Numerical Results

Python-based calculations validate the wave function for fermions:

Computed wavevectors and normalization factors for fermions

Particle	TCI	Δf (Hz)	|k| (rad/m)	A (norm.)	Saturation?
Electron	1	0.0	2.5896e+12	3.4949e+6	Yes
Up Quark	2	1.37e+20	1.323e+13	1.2033e+6	Yes
Strange Quark	14	1.06e+21	5.2978e+14	80658.0	Yes
Top Quark	582	2.00e+17	8.7716e+17	6000.1	Yes

3. Discussion

The wave function reflects structural scale (via TCI) and internal ripple mismatch (via Δf). It remains stable when transactional velocity $\Delta v < c$, with collapse at $\Delta v = c$, interpreted as vortex disintegration into lattice ripples. The normalization factor A decreases with increasing mass, indicating tighter localization of heavier particles, consistent with the short lifetimes of top quarks. The high $|\vec{k}|$ for heavy particles suggests inherent instability, supporting VEQF's deterministic collapse model. No spontaneous reassembly occurs post-collapse in current vacuum states, pending further validation. The speculative nature of l_q and the VEQF lattice model is acknowledged, as they are derived quantities within an unverified framework.

4. Implications for VEQF

The fermion wave function strengthens VEQF's framework, aligning with the Mass Emergence Model (MEM) and the interpretation of $G = \frac{c^2}{\rho \cdot T^2}$. The refined $l_q \approx 7.894781519 \times 10^{-21}$ m unifies the models, offering testable predictions for particle stability and lattice dynamics. Future work will integrate with the Gravity Emergence Model (GEM) and explore applications to proton stability or cosmological contexts.

5. Conclusion

The derivation of a deterministic, timeless fermion wave function in VEQF models particles as lattice vortices without intrinsic properties or probabilistic evolution. Collapse is a physical event tied to transactional saturation, not observer dependence. The results, validated for fermions like the electron and top quark, position VEQF as a novel alternative to conventional quantum mechanics and gravity models.

6. Appendix: Python Script

The following Python script computes the wave function parameters:

```python
# -*- coding: utf-8 -*-
"""
Final Fermion Wave Function Parameters - VEQF Framework
"""

from mpmath import mp

mp.dps = 15  # Set precision

# Fundamental constants
h = mp.mpf('6.62607015e-34')    # Planck constant (J·s)
c = mp.mpf('299792458')          # Speed of light (m/s)
k = mp.mpf('1.00297175e-26')     # Coupling constant
```

```python
l_q = mp.mpf('7.894781519e-21')   # Lattice spacing (m)
delta_x = mp.mpf('2.4e-12')        # Interaction radius (m)
M0 = mp.mpf('9.1093837e-31')       # Electron rest mass (kg)
beta = mp.mpf('1.0')               # Scaling factor
epsilon = mp.mpf('1e-4')           # Ripple support coefficient
N_modes = 5                        # Number of ripple modes

# Derived constants
hbar = h / (2 * mp.pi)             # Reduced Planck constant (J·s)
rho = h / (l_q ** 3)               # Lattice energy density (kg m^-1 s

# Define functions
def compute_k_sat():
    return (2 * mp.pi * k / l_q**3) * (delta_x**2)

def compute_k(TCI, delta_f):
    base_term = TCI**2 * M0 * c
    ripple_term = h * delta_f / c
    total_momentum = base_term + ripple_term
    return (2 * mp.pi / h) * total_momentum

def compute_A(TCI, delta_f):
    mass = TCI**2 * (M0 + beta * h * delta_f / (c * c))
    energy = mass * c * c
    return 1 / mp.sqrt(energy)

# Particle data
particles = {
    'Electron': {'TCI': mp.mpf('1'), 'Δf': mp.mpf('0.0')},
    'Up Quark': {'TCI': mp.mpf('2'), 'Δf': mp.mpf('1.37e20')},
    'Strange Quark': {'TCI': mp.mpf('14'), 'Δf': mp.mpf('1.06e21')},
    'Top Quark': {'TCI': mp.mpf('582'), 'Δf': mp.mpf('2.00e17')}
}

# Compute saturation threshold
k_sat = compute_k_sat()

# Print results
print("=== Final Fermion Wave Function Parameters ===")
print(f"{'Particle':<15} | {'TCI':<6} | {'Δf (Hz)':<12} | {'|k| (rad/
print("-" * 85)

for name, data in particles.items():
    tci = data['TCI']
    df = data['Δf']
    k_val = compute_k(tci, df)
    A = compute_A(tci, df)
```

```python
    sat = "Yes" if k_val >= k_sat else "No"
    print(f"{name:<15} | {nstr(tci, 5):<6} | {nstr(df, 5):<12} | {nst
```